

What is claimed is:

1. An embedded attenuated phase shift mask comprising a translucent substrate, an embedded phase shift layer comprised of phase shifting and attenuating material overlaying the substrate, and a layer of opaque material over laying the embedded phase shift layer, wherein areas of the opaque material have been removed to define a circuit pattern; and within the areas of the removed opaque material,
 - first regions of the embedded layer of are completely removed,
 - second regions of the embedded layer are thinned to a predetermined height equivalent to a predetermined level of attenuation, and
 - regions of the substrate adjacent the second regions of the embedded layer are etched to a predetermined depth such that radiation passing through the second region of the embedded phase shift layer is phase shifted a predetermined amount with respect to radiation passing through the first region.
2. The embedded attenuated phase shift mask of claim 1 further comprising a plurality of test cells, wherein at least one of the plurality of test cells has first attenuation and the second one of the plurality of test cells has a second attenuation different from the first.
3. The embedded phase shift mask of claim 1 further comprising a plurality of test cells, wherein at least one of the plurality of test cells has first phase attenuation and the second one of the plurality of test cells has a second phase shift different from the first.
4. A method for fabricating an embedded attenuated phase shift photomask, the photomask including a substrate, an embedded phase shift layer of known thickness and an opaque layer, the method comprising:
 - completely removing in first regions of the photomask the phase shift layer;
 - removing to a predetermined depth in the first region the substrate underlying the removed first regions of the phase shift layer; and
 - thinning in second regions of the photomask the phase shift layer to achieve a predetermined attenuation for radiation passing through the second regions;

whereby the relative phase shift between radiation passing through first regions and the second regions is equal to a desired phase shift.

5. The method of claim 4, wherein the completely removing the phase shift layer and removing to a predetermined depth areas of the substrate are undertaken during the same etching process.

6. The method of claim 4, wherein
in the second regions, the phase shift layer is thinned by an etching process that also removes an additional amount of the substrate in the first regions; and
the predetermined depth is chosen such that, after the additional amount of the substrate is removed during thinning of the phase shift layer, the total depth of the removed substrate in the first region causes a predetermined relative phase shift between radiation passing through the first and second regions.

7. The method of claim 4, wherein thinning the phase shift layer includes an etching process to remove material from the phase shift layer, and wherein a time for the second etching of the phase shift layer is chosen based on the predetermined attenuation.

8. The method of claim 7, wherein the etching process removes additional amounts of the substrate in the first regions, and wherein the predetermined depth is determined such that, after removal of an additional amount of the substrate during etching of the phase shift layer, the total depth of the removed substrate in the first region causes a predetermined relative phase shift between radiation passing through the first and second regions.

9. An apparatus comprised of a embedded attenuated phase shift mask, the embedded attenuated phase shift mask including a substrate, an embedded phase shift layer and an opaque layer, the embedded phase shift mask having fabricated thereon a plurality of test cells, wherein a first one of the plurality of test cells has exposed regions of the embedded phase shift layer adjacent to unattenuated feature regions having a first attenuation and a second one of the

plurality of test cells has exposed regions of the embedded phase shift layer adjacent to unattenuated feature regions having second attenuation.

10. An apparatus comprised of a embedded attenuated phase shift mask, the embedded attenuated phase shift mask including a substrate, an embedded phase shift layer having a predetermined thickness, and an opaque layer, the embedded phase shift mask having fabricated thereon a plurality of test cells, wherein one of the plurality of test cells has exposed regions of the embedded phase shift layer adjacent to unattenuated feature regions which has been trimmed to a thickness less than the predetermined thickness.

11. The apparatus of claim 10, wherein the one of the plurality of test cells has exposed regions of the embedded phase shift layer adjacent to unattenuated feature regions, the exposed regions being to achieve a predetermined first level of attenuation, and wherein a second one of the plurality of test cells has exposed regions of the embedded phase shift layer adjacent to unattenuated feature regions having second attenuation.

12. The apparatus of claim 10, wherein the one of the plurality of test cells includes unattenuated feature regions in which the substrate has been etched to a predetermined depth, and wherein a relative phase shift between the trimmed exposed regions of the embedded phase shift layer adjacent and the etched unattenuated feature regions is different than the phase shift between exposed phase shift layers and features in another one of the plurality of test cells.

13. A method of optimizing phase shift layer parameters of a photomask having a phase shift layer, comprising:

forming on a photomask a plurality of test cell patterns, at least two of the plurality of test cell patterns having at least one different phase shift layer parameter;

fabricating a plurality of test cells on a semiconductor substrate using the photomask, the test cells on the semiconductor substrate corresponding to the plurality of test cells in the pattern; and

evaluating the test cells on the semiconductor substrate.

14. The method of claim 13, further comprising selecting phase shift parameters for a production photomask based at least in part on the evaluation of the test cells.

15. The method of claim 13, further comprising,
simulating forming at least a part of a pattern on a semiconductor substrate using a model of at least a part of the photomask; and
validating or correcting the photomask model based on the evaluation of the test cells.